REMARKS

Claims 1, 27, 28 and 30-33 are pending. For reasons stated below in detail, Applicant respectfully submits that the claims of the present application are patentable over the prior art of record and that the present application is in condition for allowance.

I. Claim Rejections - 35 USC §103(a)

A. In the FINAL Office Action dated November 20, 2009, claims 1, 27, 28 and 30-33 are rejected under 35 USC §103(a) as being obvious over U.S. Patent Application Publication No. 2003/0062261 A1 of Shindo.

Independent claims 1, 30 and 32 of the present application are directed to a hafnium sputtering target and/or a hafnium thin film produced via sputtering deposition of the sputtering target. The claims of the present application require a high purity hafnium material having an extremely reduced zirconium content of 1 to 1000wtppm as well as extremely reduced contents of oxygen, nitrogen, carbon, iron, chromium and nickel.

As has been argued before, it is understood by one of ordinary skill in the art that "hafnium and zirconium are very similar in terms of atomic structure and chemical property" and that the inclusion of zirconium in hafnium is not acknowledged as a problem in the prior art of record. The prior art '261 Shindo publication provides evidence of this sentiment and provides the following teaching to one of ordinary skill in the art:

> " ... a large quantity of zirconium is contained in hafnium, and notwithstanding the fact that the separation and refinement between the two is difficult, this may be ***disregarded*** since the purpose of use of the respective materials ***will not hinder overall purpose*** hereof" (see Paragraph No. 0061 of the '261 Shindo published application);
>
> and

> "It is extremely difficult to reduce Zr in high purity hafnium ... the fact that Zr is mixed in high-purity hafnium ***will not aggravate the properties of semiconductors, and will not be a problem***." (See Paragraph No. 0065 of the '261 Shindo published application).

Accordingly, the teaching of the cited prior art reference is that Zr content in a highly pure hafnium material is irrelevant since the Zr content "will not aggravate the properties of semiconductors", "will not be a problem", "may be disregarded", and "will not hinder overall purpose". This teaching to one of ordinary skill in the art by the cited prior art reference cannot be any clearer.

Despite this teaching, it is determined in the FINAL Office Action that the expression "Zr content of 0.5% or less" in the same prior art reference that teaches that Zr content in a highly pure hafnium material is irrelevant since the Zr content "will not aggravate the properties of semiconductors", "will not be a problem", "may be disregarded", and "will not hinder overall purpose", reads on 0% content of Zr and therefore overlaps the claimed Zr content of 1 to 1000wtppm required by the claims of the present application. Applicant respectfully request reconsideration.

The rejection in the FINAL Office Action with respect to 0% content of Zr is interpreting the cited reference in a manner in which a virtual substance is assumed based on idealization rather than a practical real world interpretation. The cited reference includes working examples that provides a lower limit that is neither 0% Zr content nor Zr content below 1000wtppm.

One of ordinary skill in the art at the time of the invention clearly understood that no matter what kind of purification technology is employed, it is impossible to achieve a Zr content of 0%. The Zr content in the Hf material described in the cited reference by necessity entails a lower limit value together with the disclosed upper limit value of 0.5%. A practical analysis of the lower limit is provided by the specific examples recited in the reference. The foregoing

lower limit value is considered to be dependent on the specific purification technology actually disclosed by the reference, the type of starting material, the type of impurities, and other practical matters.

The lower limit is not expressly disclosed in the expression "Zr content of 0.5% or less", yet it clearly exists. One of ordinary skill in the art may reasonably estimate the lower limit value based on analytical values specifically disclosed in the Examples of the reference. Here, the lower limit values are clearly disclosed as being 3500wtppm and 2400wtppm. Thus, it would appropriate for one of ordinary skill in the art to determine the lower limit value of Zr to be approximately 2400ppm. As such, this does not render the requirement of zirconium content of 1 to 1000wtppm to be obvious to one of ordinary skill in the art particularly when the reference teaches one of ordinary skill in the art that Zr content in a highly pure hafnium material is irrelevant since the Zr content "will not aggravate the properties of semiconductors", "will not be a problem", "may be disregarded", and "will not hinder overall purpose".

The method disclosed by the cited reference is a method of separation and refinement based only on nitric acid cleaning and electron beam melting. Since this method relies on the difference of chemical behavior between Hf and impurities, it is extremely difficult to separate elements, such as Zr from Hf, which have similar chemical properties. Thus, the method disclosed by the prior art is ineffective for reducing the Zr content which exists in the Hf material in a quantity exceeding 1000wtppm. The Zr content will remain about the same in the processed Hf material as that of the Hf raw material. Moreover, Hf is contained as an impurity in Zr and is obtained as a by-product of Zr refining. Accordingly, the production of Hf is performed simultaneously with the production of Zr. Thus, Hf raw material will always contain a certain

amount of Zr; thus, it is conventional to treat and identify the purity of a Zr or Hf material without giving consideration to Hf or Zr as an impurity.

In contrast to conventional views with respect to Hf and Zr, Applicant's invention is directed at reducing Zr content in highly pure hafnium since Applicant has newly determined that such reduction is critical relative to the stability of electronic components and provides an unexpected result in view of the above statements with respect to the irrelevance of Zr content in Hf material as taught by the prior art reference. For example, see page 2, lines 14-19, of the present application, as filed, which states:

> "... in recent years, deposition on electronic components using hafnium silicide is being demanded. In such a case, even zirconium content is an impurity, and there is a possibility that the required characteristics of the hafnium raw material may become unstable."

The prior art provides Zr contents reduced to 5,000wtppm, 3,500wtppm and 2,400wtppm in high-purity hafnium, and this presence of Zr is clearly not expected to aggravate the properties of semiconductors as taught by the reference. Thus, it is clearly unexpected to one of ordinary skill in the art following the teachings of the reference that the presence of Zr at levels of 5,000wtppm, 3,500wtppm and 2,400wtppm will cause a hafnium silicide film of an electronic component to become unstable. However, as stated directly in the specification of the present application, as filed, this is not true for all electronic components and stability can be an issue.

Thus, Applicant respectfully submits that a Zr content of 1 to 1000wtppm as required by the claims of the present application is critical and provides an unexpected result relative to the teachings provided to one of ordinary skill in the art by the cited reference. In addition, Applicants submit that it is an error to conclude that the cited reference teaches 0% Zr content.

Accordingly, Applicant respectfully submits that a Zr content of 1 to 1000wtppm provides an unobvious and patentable difference between the disclosure and teachings of the

cited reference and the subject matter required by the independent claims of the present application. For at least this reason, Applicant respectfully requests reconsideration and removal of the above referenced rejection of claims 1, 27, 28 and 30-33 of the present application.

B. In the FINAL Office Action dated November 20, 2009, claims 1, 27, 28 and 30-33 are rejected under 35 USC §103(a) as being obvious over the publication in the ASM Handbook of Murray titled "Preparation and Characterization of Pure Metals" in view of U.S. Patent Application Publication No. 2003/0062261 A1 of Shindo.

In the FINAL Office Action, Murray is interrupted as providing the following disclosure:

> "Murray discloses (p. 1094, col. 3) that if a low-iron starting material is used, chemical vapor deposition will produce a condensed vapor with a purity level of 99.999% (5N) and hafnium is one of the metals that have purified by chemical vapor deposition."

Applicant respectfully submits that the ASM Handbook Volume 2, pp. 1093-1097, does not provide any analytical data concerning the impurities, such as Zr, contained in Hf. Accordingly, Applicant respectfully submits that an interpretation of Murray disclosing hafnium having a Zr content of 1 to 1000wtppm is incorrect. Reconsideration is respectfully requested.

The above rejection relies on the disclosure in the section of the ASM Handbook having the sub-heading "Chemical Vapor Deposition" which begins in column 2 and ends within column 3 of page 1094 of the cited reference. The first and second sentences of the second paragraph of this section states:

> "One of the more popular of the chemical vapor deposition processes is the iodide process, which has been used extensively to purify **titanium, zirconium, and chromium (Ref 5)**. For each of **these metals**, the starting charge of metal is reacted to form a volatile metal-iodide compound, which in turn is thermally decomposed to liberate iodide vapor."

Accordingly, the use of the phrase "these metals" in the above recited section of Murray is clearly directed to the metals "titanium, zirconium and chromium", not hafnium.

Further, the expression "In this process" recited in the first full paragraph on column 3 of page 1094 clearly refers to the "iodide process" identified in the previous paragraph. Thus, this first full paragraph of column 3 describes specific purities of Ti, Zr, and Cr material which were purified and refined based on the iodide process and states that "Only iron is carried over with these metals to a significant extent." Accordingly, it is clear to one of ordinary skill in the art that the phrase "these metals" recited in the first full paragraph of column 3 refers specifically to Ti, Zr, and Cr, not Hf.

Still further, in the last sentence of the first full paragraph on column 3 which states "Thus, if a low-iron starting metal is used, the condensed vapor will approach a purity level of 99.999%", one of ordinary skill in the art understands that the "low-iron starting metals" that will "approach" (not reach) a 5N purity level are Ti, Zr, and Cr, not Hf. Applicant respectfully submits that one of ordinary skill in the art cannot acknowledge that high purity hafnium having a purity level of 5N can be obtained based on this paragraph of Murray.

Moreover, the second full paragraph on column 3 of page 1094 states that:

> Other metals that have been purified by chemical vapor deposition include **hafnium**, thorium, vanadium, niobium, tantalum, molybdenum, and many less commercially important metals **(Ref. 5)**."

As the source of the forgoing statement, on Page 1097 Murray identifies "Ref. 5" as "R.F. Rolsten, *Iodide Metals*, Wiley, 1961". Pages 74-77 of Rolsten ("Ref. 5") are provided via an Information Disclosure Statement filed herewith and disclose an iodide process for Hf. The last few lines on page 76 of Rolsten states:

"Hafnium that was prepared in six deposition experiments ranged from 98.92 to 99.22% purity and contained 140 to 500 ppm oxygen and 70ppm to not detected nitrogen."

Thus, the purity of the hafnium material disclosed by Rolsten and referenced by Murray is in the range 98.92% to 99.22% and is not of 4N5 (99.995%) purity as required by the claims of the present application. Applicant respectfully submits that one of ordinary skill in the art at the time of the present invention has no reason to conclude that an Hf material can be obtained from use of the iodide process based on these references. Applicant respectfully submits that any other interpretation of these references is flawed.

Similar to the '261 Shindo prior art, the "iodide process" referred to by Murray and Rolsten is a method of separation relying on the difference of chemical behavior between Hf and impurities. As stated previously, it is extremely difficult to separate elements, such as Zr from Hf, which have similar chemical properties. Thus, the iodide process disclosed by Murray and Rolsten is ineffective for reducing the Zr content which exists in an Hf material in a quantity exceeding 1000wtppm. The Zr content will remain about the same in the iodide processed Hf material as that of the Hf raw material. Thus, the iodide process has virtually no effect in separating Hf and Zr that have similar chemical properties.

Moreover, Hf is contained as an impurity in Zr and is obtained as a by-product of Zr refining. Accordingly, the production of Hf is performed simultaneously with the production of Zr. Thus, Hf raw material will always contain a certain amount of Zr; thus, it is conventional to treat and identify the purity of a Zr or Hf material without giving consideration to Hf or Zr as an impurity. Thus, even the low-iron Zr material of Murray that may "approach" a purity level of 99.999% contains a considerable amount of Hf; however, this purity level is calculated with Hf

not being considered an impurity. As stated above, the iodide process will not remove the Hf from Zr.

For all the reasons stated above, Applicant respectfully submits that claims 1, 27, 28 and 30-33 of the present application are not obvious in view of the ASM Handbook and/or Rolsten in view of the '261 Shindo publication. Applicant respectfully requests reconsideration and removal of the rejection.

II. Conclusion

In view of the above remarks, Applicant respectfully submits that the claim rejections have been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

Please charge any deficiency or credit any overpayment for entering this Amendment to our deposit account no. 08-3040.

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